25X1

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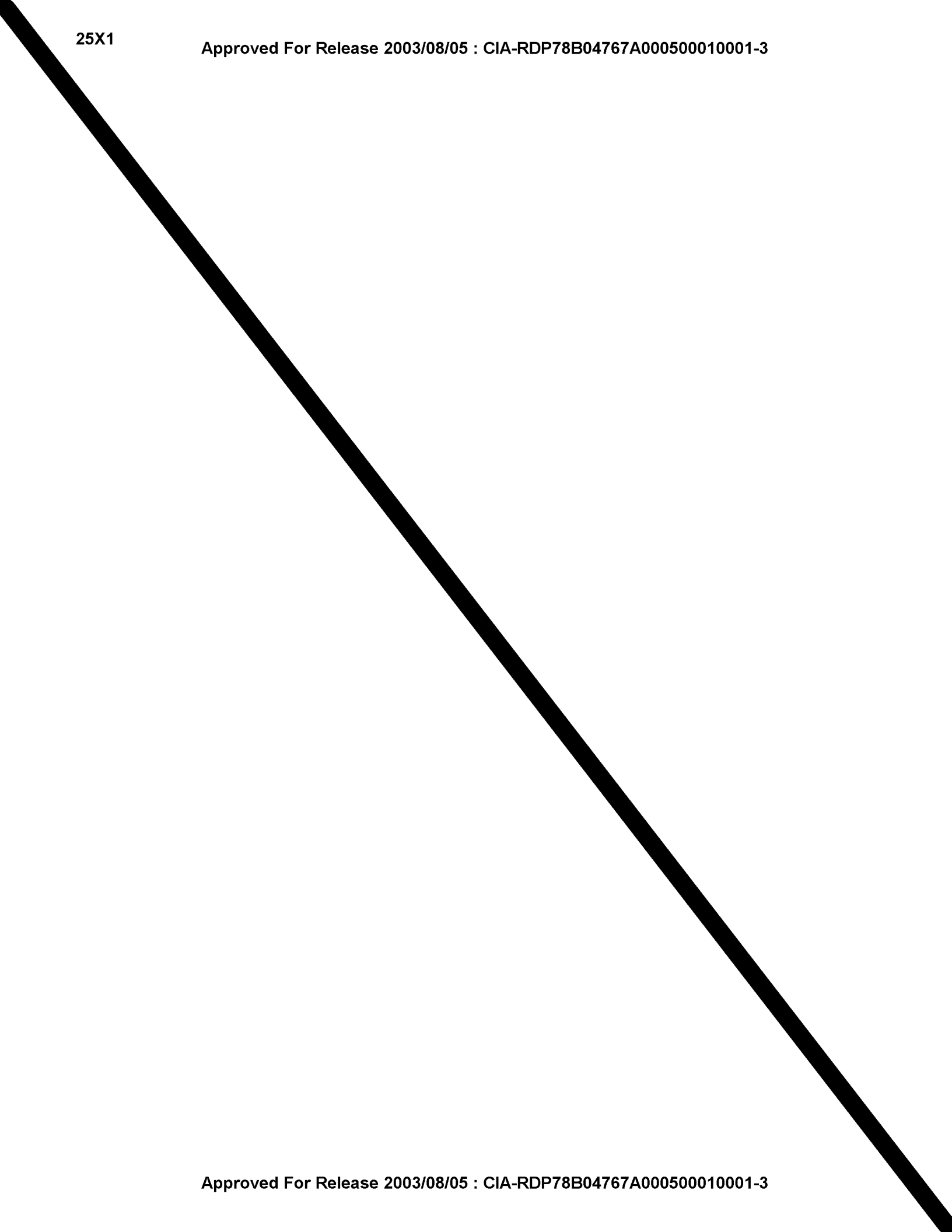

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25X1 [redacted]

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[redacted] 25X1

10 December 1970

Copy 1

MEMORANDUM FOR: Chief, Image Evaluation Branch, APSD/TSG/NPIC

SUBJECT: Original Negative Evaluation Handbook; Tonal Analysis Experiment - Project 920083

1. Technologists within the Image Evaluation Branch have evaluated the tonal section of Chart I (Data Collection and Generation of Target Data and Mission Summary Files) of the Operational Handbook for Evaluation of Original Negative. The purpose of the experiment was to validate the theory of the proposed tonal analysis and to apply this theory to domestic 25X1 [redacted] Chart I on page 2 depicts the data generation phase of the U.N. Handbook. The circled blocks are those investigated in this experiment.

25X1 2. [redacted] a summer intern employee, assisted in analyzing each of the blocks and subsequently programmed each one in FORTRAN under the Open Shop guidelines. The programs were tested on actual imagery from 25X1 [redacted] Eight frames of domestic coverage containing CORN targets were selected for analysis. The frames are:

[redacted] 25X1

THE COMPUTERIZED PROCEDURE

3. Required data inputs to the computer program for each frame include:

Item	Source	Units
sun elevation	MCD	angle in degrees
mirror position	MCD	none (fwd, vert, aft)
film speed	MCD	velocity in inches/seconds 25X1
slit width	MCD	width in inches

GROUP 1
Excluded from automatic downgrading and declassification

[redacted]

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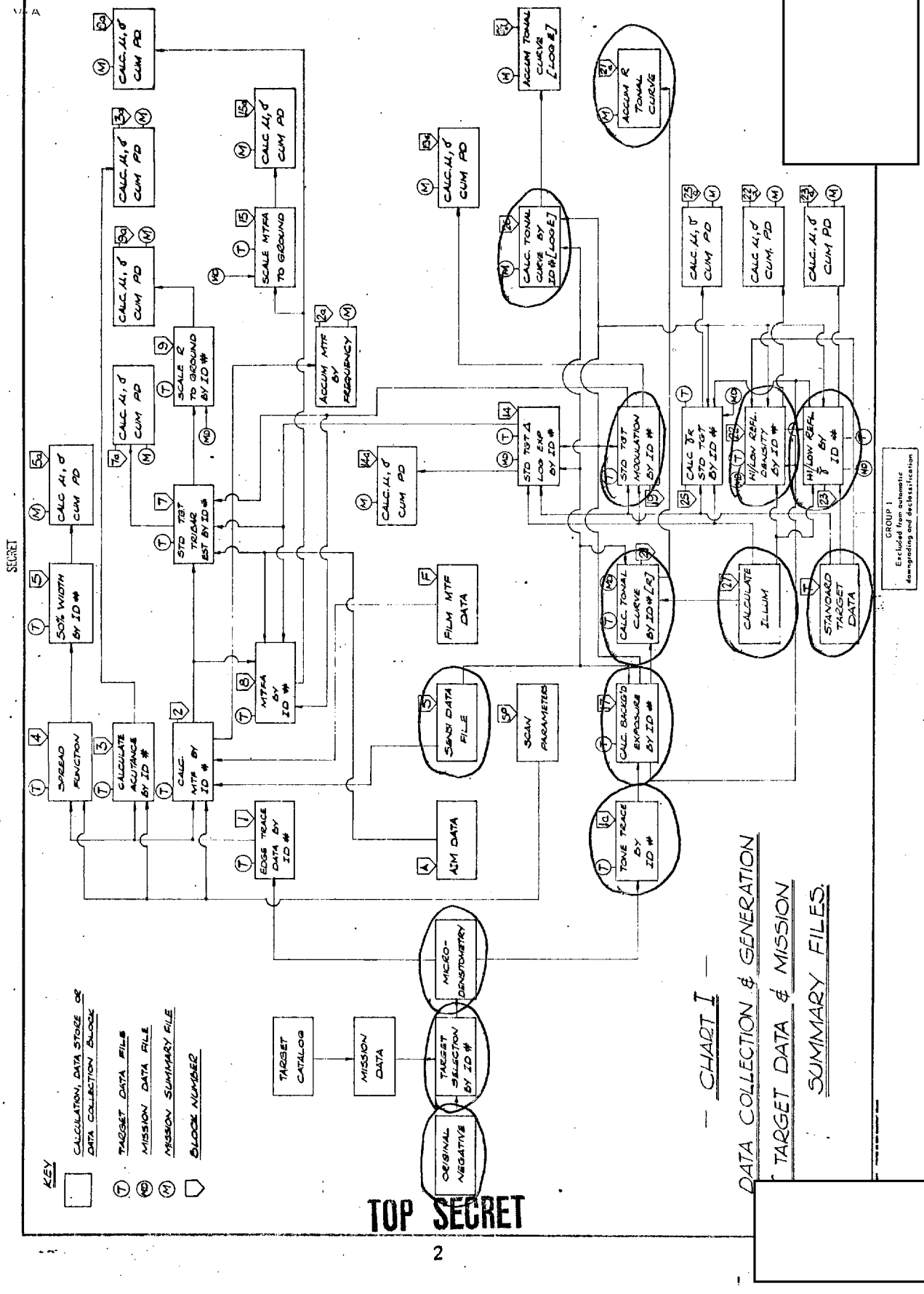

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Required inputs to the computer program from other sources include:

a. Graph of Target Illumination versus Sun Angle

b. Microdensitometer trace of R-2 21-step wedge

c. Microdensitometer trace of CORN 5-step gray scale

d. Microdensitometer trace of low ground reflectance area

e. Absolute Log Exposure of Step 11 of R-2 wedge

f. Minimum and Maximum reflectance values of the specified standard target

4. Detailed program documentation will not be given in this memorandum. Documentation of the theory is given in the ON Handbook. A source listing of the program and input/output data is available. Output data includes:

a. Table of density versus absolute exposure for a mission

b. Table of Effective Tonal Curve for each target--a tabulation of density, exposure from ground, target luminous emittance, and target reflectance

c. Background exposure due to atmosphere

d. Target illuminance

e. Minimum and Maximum exposure for standard target

f. Standard target modulation

g. High and low reflection density

h. Standard target reflection gamma

25X1

i. Graph of effective tonal curve (density versus log exposure)

5. Upon completion of the computerized analysis of the eight [redacted] frames, the following results are observed:

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[redacted]

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a. Minor program corrections are required; however, these corrections will not alter the following three results.

b. A computerized interface between the microdensitometer output and FORTRAN programs is required. The method of hand transfer of data from microdensitometer graphs to punched cards is too time consuming for large volume analysis. ISAB/DAS is presently working on this problem.

c. Some items computed in the ON Handbook are good for long-term comparative analysis only. For example, standard target reflection gamma for any one frame contributed nothing to our analysis.

d. Some computed ground reflectance values were greater than one.

EXAMINATION OF ERRORS

6. Result d in paragraph 5 is a physical impossibility (barring self-luminance) and obviously required extensive investigation. A re-examination of the evaluation scheme was made to determine possible sources of error. First, the microdensitometer scans were repeated for the R-2 wedge, the CORN five-step gray scale, and low ground reflectance area. Although differences on the order of .05 density were observed between similar traces, the discrepancies do not account for the large error of reflectances greater than one. Second, input constants were examined to determine their contribution to error. Ground illuminance, atmospheric transmission, lens T-stop, exposure time, and haze contribution contained some error but none could account for computed reflectances greater than one. Finally, the data for six frames was hand computed using simplified but accurate equations and techniques. The results were essentially the same and are listed in Table 1 (see page 5).

7. It was suspected that the adjacency effect (Eberhard Effect in this case) due to dual gamma processing was the cause of the resultant error. This would be logical because the gray scale images are small and the greatest error is on the highest density steps. To further substantiate this suspicion, the same mathematical technique was applied to [redacted] 25X1
25X1 [redacted] was the most recent [redacted] to receive conventional 25X1
spray processing and the adjacency effect would not be expected to be a significant factor in reflectance evaluations. Four frames containing CORN 5-step gray scales were selected. The frames are: 25X1

25X1

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25X1

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25X1

25X1

TABLE 1

Actual and Computed Reflectance Values of CORN 5-Step Gray Scale,

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[redacted] 25X1

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The exact same techniques and calculations were applied to [redacted] 25X1
25X1 as were used for [redacted] The computed reflectance values are shown in Table 2.

TABLE 2
Computed Reflectance Values of CORN 5-Step Gray Scale, [redacted] 25X1

[redacted] 25X1

The actual reflectance values for [redacted] are not available, but an 25X1
inspection of the computed values will show that they are "close" to the usual 5-step gray scale reflectance. The horrendous error of reflectances greater than one have been eliminated. This is one more proof that adjacency effect in dual gamma processing is the major source of error in reflectance calculations on imagery which has received this processing. The problem arises in the failure of the macro D/Log Exposure curve (standard dual gamma curve) to accurately relate exposure from micro-density readings.

25X1 8. [redacted] has recommended an interim method of handling the density versus exposure problem in dual gamma processing. When working with microdensities, [redacted] suggests using an altered 25X1
D/Log Exposure curve as shown in Figure 1, page 7.

25X1

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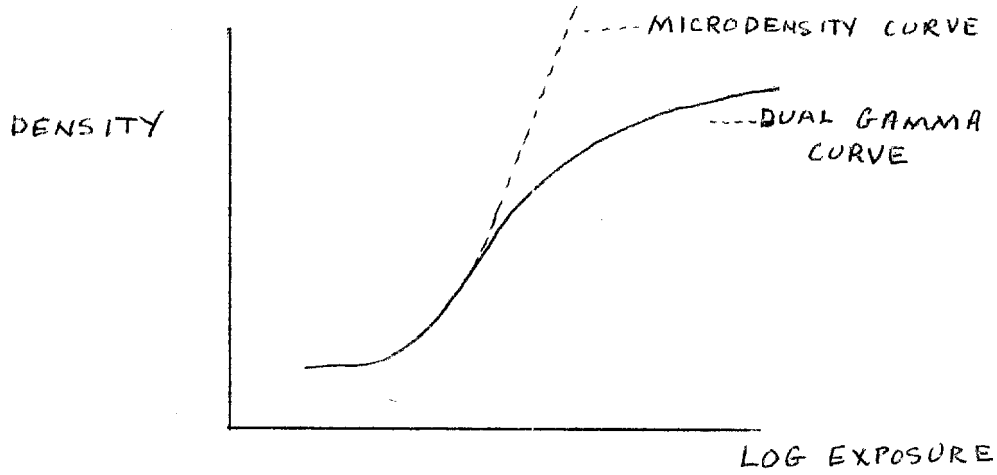
Figure 1: Altered D/Log Exposure Curve for Microdensities



25X1

9. The altered curve for microdensities was tested on [redacted] The first three frames used in the original computations (Table 1) were again used in this portion of the evaluation. The results are shown in Table 3. Columns 1, 2, and 3 are repeated from Table 1. Column 4 lists the results using the altered curve for microdensities.

25X1

Table 3

[redacted]

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It can be seen that using the Suggested Microdensity Curve brings the fifth step into line, leaves the fourth somewhat high (although improved over the Standard Dual Gamma Curve), and does not change the first three steps as compared to the Standard Dual Gamma Curve.

CONCLUSIONS/RECOMMENDATIONS

10. As a result of the Tonal Analysis Experiment, the following conclusions and subsequent recommendations are made:

a. The adjacency effect associated with dual gamma processing is by far the greatest source of error in density versus ground reflectance curves for micro-images. A further examination of this problem is probably beyond the purview of APSD. It is recommended that APSD vigorously support any attempt by other organizations to model the adjacency effect in dual gamma processing. This might take the form of a three dimensional D/Log Exposure curve, or a mathematical model of the development process.

b. The transmission of the atmosphere is an unknown in the process which contributes to considerable uncertainty. An [redacted] report suggests a constant of 0.8 for atmospheric transmission. Another source recommends .65. In fact, the number is probably variable from frame to frame over a considerable range. A further examination of this problem also appears beyond the purview of APSD. It is recommended that APSD vigorously support any attempt by other organizations to investigate the effects of the atmosphere on the photographic process.

25X1

c. Microdensitometer traces of the same target produced differences in density on the order of .05. This type of error was not the major problem in this tonal investigation, but it might be significant after other larger sources of error are eliminated. It is recommended that as the APSD microdensitometer system matures, a quality control procedure be considered as an integral part of the system.

d. Ground reflectance values on a target by target basis are required as input to the tonal analysis of the ON Handbook. It is recommended that as an interim measure, the target reflectance values provided from target brightness studies be used as a data source for the ON Handbook. This data is provided only for general target types and may not be specific enough for target by target analysis. This will have to be watched during future evaluations.

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e. An immediate application of the tonal analysis is exposure evaluation of operational systems (Block 14 of Chart I). An exposure evaluation scheme oriented toward photo-interpretation suitability can be developed to any degree of complexity for any operational system. It is recommended that an exposure evaluation scheme be developed for the [redacted] This has already begun in IEB under project 450477. ISAB support in image motion evaluation has been solicited [redacted]

25X1

25X1

f. The tonal evaluation method as proposed in the ON Handbook is feasible. Some adjustments will have to be made because of dual gamma processing. Sources of error exist in the technique and refinements will have to be made. The procedure could be implemented immediately; however, two reasons indicate a slower approach. First, several parameters computed in the ON Handbook are for long-term analysis only. The usefulness of these numbers is not known at present and cannot be determined until they have been accumulated over a series of missions. Second, parts of the output of the original negative tonal analysis are input to the duplicate product evaluation. A better interface can be achieved between ON and DP tonal analysis after the duplicate product evaluation procedure is accepted. It is recommended that the emphasis in implementation in tonal analysis be placed on exposure evaluation (as indicated in item e above). A low key effort can be maintained in the remainder of the ON tonal analysis in coordination with the DP effort.

[redacted]

25X1

Section I
IEB/APSD/TSG/NPIC

Distribution:
Cy 1 - NPIC/TSG/APSD/IEB, 920083 ✓
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25X1

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